Digital modeling version 2.0

ABVENT

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Three-dimensional modeling software is now the norm in architects' offices.

The current generation of software platforms allows data sharing as well as real-time monitoring of the construction site.

"At the beginning of the 1980s, a few pioneering architects started using software to design their buildings," explains Philippe Butty, CEO of Abvent Suisse. "Since then, the situation has been inverted: only a handful now allow themselves the luxury of hand-drawn blueprints." Within just a few years computer aided design (CAD) software such as Archicad (Abvent), Revit (Autodesk), MicroStation (Bentley Software) and Allplan (Nemetschek), has become an essential tools for architects.

Now another revolution is under way. "We are witnessing the birth of what you might call CAD 2.0," says Jeffrey Huang, Director of EPFL's Media and Design Laboratory. In this new generation, design by computer is becoming collaborative. "From now on people are going to be using virtual platforms like Second Life and Multiverse," explains Architect Russell Loveridge, a doctoral student at EPFL's Laboratory for the Production of Architecture. "These allow people, whether or not they are involved in a project, to visit, explore, interact with and comment on a 3D model of a building. Architects and designers are also making use of freeware like GoogleEarth (which now allows one to insert a 3D building model) to share their projects with the rest of the world, and to show their designs in the setting of the environment they will face in reality."

In addition to creating 3D images, architects are using these new tools to share more and more information with the other participants in their projects, including investors and project managers. Known as BIM 2.0 (for Building Information Modeling), the new concept is described variously as "Modeling architectural data," "Modeling building data," or "Virtual building." Explains Loveridge: "BIM is the architectural equivalent of the production models used in the aircraft and automobile industries."

More than just a software package, BIM is a methodology. It brings together in one database all the data for a project from the initial concepts to the details of final construction, including drawings, 3D views, material specifications, budgetary details and progress reports.

This database is a complete numerical simulation of the building project, a platform from which all those involved, from the architect to the engineering design office to the project manager, can interact. "Like an RSS web feed, the database is updated instantaneously whenever a change is made, keeping everyone informed in real time," says Huang. The parametric design engines in modern software ensure that any change diffuses rapidly throughout the entire project, updating 3D views, drawings, nomenclature, sectional views, plans and any other images. All this takes the form of a digital model that is gradually built, allowing a visual view of the advancing work.

It's a fundamental–and strategic–change. Currently, only those who create the basic design and the construction details of a building have all the relevant information. And pulling together all the pieces of the puzzle to provide virtual images to those doing the actual building can be tricky – and costly. Missed deadlines and budget overruns often accumulate because the digital design is far removed from the hard reality and relatively old-fashioned habits of a construction site.

The U.S. architectural firm Skidmore, Owings & Merrill (SOM) is one of the first to have used BIM 2.0-compatible software, for the emblematic Freedom Tower project, the 541 m high building that will replace the Twin Towers at the heart of Manhattan. According to the firm's own figures, BIM effectively reduced the volume of documentation from "20,000 CAD files to five architectural databases." It's been a conclusive experience, says the firm, which is working on this project with more than 100 participating firms.

But a word of caution: BIM 2.0 also has its downside for architects. "It is sometimes imposed on them by a 'dark force'," notes Huang. "Clients and contractors, realizing the savings that it can bring, are pushing its introduction in our industry. But for architects, using BIM is often painful. Building a numerical simulation of the complete project takes time, and above all, freezes the project, interrupting those moments of creative doubt that are essential to a really excellent design." ■

COMPUTER-CONTROLLED MANUFACTURING

Architects use Computer-Aided Design (CAD) software because, among other things, it allows them to design just about any shape. "But the 3D images produced this way are only virtual, and must somehow be converted into a workable design," says architect Ivo Stotz, a doctoral student at EPFL's Laboratory for Timber Construction. "It's a lot of work to find shapes and forms that can really be built."

EPFL's Laboratory for the Production of Architecture is concentrating on developing a "numerical chain." In practical terms, Loveridge says, that means creating "CAD and 3D modeling software that use the same database, from the computer that produces the image to the one that controls the manufacture of the components. There are three types of manufacturing process: rapid prototyping, CNC manufacturing (Computer Numerical Control) and automated production."

The "3D printing" form of rapid prototyping constructs the three-dimensional shape by superposing thin slices of material, each one corresponding exactly to the appropriate section of the CAD model. "This technology is quick, but the number of prototypes it can produce is limited," Loveridge explains. "CNC manufacturing gives an architect more freedom to directly monitor the process of manufacturing components." Looking ahead, the type of automated production that is commonly used to produce cars is beginning to be used in making prefabricated housing and complex assemblies for other buildings.

EPFL is working with the University of Lyon to develop software inspired by fractal geometry to simplify the passage from the virtual to reality. "We define an array of points over the surface of a 3D architectural form, creating a quadrilateral mesh: the greater the number of points, the finer the size of each element," explains Eric Tosan, a computer scientist at the University of Lyon. "These quadrilateral elements represent the wooden panels used in the actual construction. Thus it is possible to go directly from the 3D image to the machining of the panels, the software calculating the set of characteristics for each one." This technique should enable more complex shapes to be fabricated while at the same time reducing costs. ■

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